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(54) Linearizer bridge circuit

Linearisierungsbrückenschaltung

Circuit en pont de linéarisation

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(56) References cited:
EP-A- 0 544 117
US-A- 5 304 944
US-A- 5 317 288

- **ABDEL-MESSIAH KHILLA: "LINEARISIERER FUR WANDERFELDROHREN IN ZUKUNFTIGEN NACHRICHTENSATELLITEN UND BODENSTATIONEN" FREQUENZ, vol. 48, no. 9/10, 1 September 1994, pages 227-232, XP000479975**

Description

[0001] The present invention relates generally to travelling wave tube amplifiers (TWTAs), and more particularly, to a linearizer bridge circuit for use with such travelling wave tube amplifiers.

[0002] Nippon Electric Corporation (NEC) has developed a linearizer bridge circuit that uses an amplifier as a distortion generator. The NEC linearizer is rated at 4 watts, and weighs 650 grams. ANT Bosch Telecom has developed a linearizer bridge circuit. This system has dimensions of 2.6 centimetres by 1.6 centimetres. Four substrates are required to produce the ANT Bosch Telecom circuit, and it cannot be used to adjust the power transfer curve of a travelling wave tube amplifier. The ANT Bosch Telecom linearizer bridge circuit has an architecture that is similar to the present invention, but is constructed using different components that provide lower performance than the present invention and that operate at higher power levels.

[0003] Accordingly, it is an objective of the present invention to provide for an improved linearizer bridge circuit for use with a travelling wave tube amplifier. The present invention also seeks to provide for a high performance Ku-band linearizer bridge circuit that operates at reduced power levels compared to conventional circuits.

[0004] According to the invention there is provided a linearizer bridge circuit for use with a travelling wave tube amplifier, comprising a linearizer bridge comprising an RF input for receiving an RF input signal, a linear arm comprising a fixed delay line and a diode phase shifter, a nonlinear arm comprising a nonlinear Schottky diode distortion generator circuit and a PIN diode attenuator, an input coupler for coupling the RF input signal to the linear and nonlinear arms of the linearizer bridge, and an output coupler for combining the RF signals from the linear and nonlinear arms to provide an RF output signal from the linearizer bridge, an output amplifier coupled to the linearizer bridge for amplifying the RF output signal from the linearizer bridge, and an output attenuator coupled to the output amplifier for providing an RF output signal from the linearizer bridge circuit, wherein the improvement is
characterized by:

a control circuit coupled to the phase shifter, the nonlinear Schottky diode distortion generator circuit, the PIN diode attenuator, the output amplifier and the output attenuator, for applying selected amounts of bias to the Schottky diode distortion generator, the phase shifter, and the PIN diode attenuator to lower the operational power level of the linearizer bridge circuit and selectively adjust the phase advance gain expansion and gain curvature of the linearizer bridge circuit, and for applying selected amounts of bias to the output amplifier and output attenuator to set the respective gain and attenuation values thereof; and wherein proper adjustment of the settings of the Schottky diode distortion generator, the phase shifter, and the PIN diode attenuator, produces a desired gain expansion and phase advance with respect to the power level of the RF input signal applied to the linearizer bridge circuit, which cancels the gain compression and phase lag generated by the travelling wave tube amplifier to improve its linearity performance.

[0005] The present invention enables the provision of a Ku-band integrated, compact size. low cost, pre-distortion type linearizer bridge circuit. The purpose of the linearizer bridge circuit is to improve the linearity performance of a travelling wave tube amplifier with which it is used.

[0006] The linearizer bridge circuit is comprised of linear and nonlinear arms. The linear arm comprises a phase shifter and a fixed delay, and the nonlinear arm comprises a Schottky diode distortion generator and a PIN diode attenuator. A control circuit is used to set various bias settings for the circuits of the linearizer bridge circuit. All circuits may be integrated on a single substrate, which may preferably be comprised of alumina. Compact size, lower parts count, reduced assembly and RF tuning and test labour costs are realized with the present linearizer bridge circuit.

[0007] By applying a DC bias to the Schottky diode in the distortion generator circuit, the operational power level of the present linearizer bridge circuit is much lower than a conventional linearizer bridge. The major advantage of this feature is that there is less heat dissipation in the circuit and less DC power is required for operation. In addition, lower operational power levels lead to better c/3IM performance in bypass mode.

[0008] Another important possibility with the present invention is that, by changing the bias applied to the distortion generator, the phase shifter and the attenuator, instead of making the conventional phase shifter and attenuator adjustments, the present linearizer bridge circuit is capable of adjusting not only phase advance gain expansion, but also gain curvature. This feature leads to the better match between the present linearizer bridge circuit and various travelling wave tube amplifiers with which it is employed.

[0009] The linearizer bridge circuit is integrated, in that it is much more compact in size (1.4 x 1.0 centimetres) and has lower power consumption (80 mW) than comparable competing designs. The linearizer bridge circuit also has a relatively wide bandwidth (approximately 3 GHz). The linearizer bridge circuit provides both active and bypass functions. Its power transfer curve may be adjusted for use with different travelling wave tube amplifiers.

[0010] In order that the invention and its various other preferred features may be understood more easily some embodiments thereof will now be described by way of example only, with reference to the accompanying

drawing, wherein like reference numerals designate like structural elements, and in which:-

Fig. 1 illustrates a conventional linearizer bridge circuit;
Fig. 2 illustrates a linearizer bridge circuit in accordance with the principles of the present invention;
Fig. 3 is a detailed schematic diagram of the linearizer bridge circuit of Fig. 2: and
Fig. 4 is a block diagram of the control circuit employed in the linearizer bridge circuit of Fig. 2.

[0011] Referring to the drawing figures, Fig. 1 illustrates a conventional linearizer bridge circuit 10 that may be used with a travelling wave tube amplifier (TWTA) 20. The linearizer bridge circuit 10 depicted in Fig. 1 is representative of one manufactured by ANT Bosch Telecom.

[0012] The conventional linearizer bridge circuit 10 has an RF input 11 for receiving an RF input signal that is coupled by way of an input phase shifter 12 and an input variable attenuator 13 to a preamplifier 14. The input variable phase shifter 12 is commandable in order to compensate for the electrical length of the difference between linear and nonlinear arms 21a, 21b of a linearizer bridge 15 and provide for parallel connection of the linearizer bridge 15. The output of the preamplifier 14 is coupled to the linearizer bridge 15. The output of the linearizer bridge 15 is coupled to an output stage 16 that includes an attenuator 17 and an amplifier 18. The output stage 16 has an RF output 19 for providing an RF output signal from the linearizer bridge circuit 10 that is coupled to a travelling wave tube amplifier 20.

[0013] The conventional linearizer bridge 15 has separate RF paths 21a, 21b comprising linear and nonlinear arms 21a, 21b, respectively. The linear arm 21a includes a fixed delay line 22 and a phase shifter 23. The nonlinear arm 21b includes a distortion generator circuit 24 and a PIN diode attenuator 25. The PIN diode attenuator 25 is controlled by a resistive circuit containing a thermistor (not shown). The resistor values are optimized to vary the attenuation of the attenuator 25 over the operating temperature range in order to compensate for the gain variation of the linearizer bridge circuit 10 and travelling wave tube amplifier 10. The net gain of the conventional linearizer bridge circuit 10 is about 15 dB, but this value may be adjusted to be 64 dB at a nominal output power by adding preamplifier stages.

[0014] Referring now to Fig. 2, it shows an RF block diagram of an improved linearizer bridge circuit 30 in accordance with the principles of the present invention. The linearizer bridge circuit 30 is designed for use with the travelling wave tube amplifier 20. The linearizer bridge circuit 30 is used as an interface between a channel amplifier 31 and the travelling wave tube amplifier 20. The channel amplifier 31 provides an amplified RF input signal to the linearizer bridge circuit 30. The linearizer bridge circuit 30 comprises a linearizer bridge 15a that has an RF input 11 for receiving the amplified RF input signal from the channel amplifier 31. The output of the linearizer bridge 15a is coupled by way of an output amplifier 32 and an output attenuator 33 to an RF output 19. The RF output 19 couples an RF output signal from the linearizer bridge circuit 30 to the travelling wave tube amplifier 20.

[0015] The linearizer bridge 15a is a balanced bridge circuit having separate RF paths 21a, 21b comprising linear and nonlinear arms 21a, 21b, respectively. The linear arm 21a comprises a fixed delay line 22a and a phase shifter 23, such as is disclosed in our U.S. Patent No. 5,317,288. The phase shifter 23 uses PIN diodes (not shown) and has a wide, 360 degree, phase shift range. The nonlinear arm 21b comprises a nonlinear distortion generator circuit 24a that uses Schottky diodes, and a PIN diode attenuator 25. Input and output hybrid couplers 27a, 27b may be used to couple the RF signal to and from the linear and nonlinear arms 21a, 21b of the linearizer badge 15a. All of the circuits of the linearizer bridge 15a are fabricated on a single substrate 26, which may preferably comprise alumina.

[0016] A control circuit 35 is coupled to the phase shifter 23, nonlinear Schottky diode distortion generator circuit 24a, and the PIN diode attenuator 25. The control circuit 35 has inputs for receiving on and off input command signals, and an output for generating a bilevel telemetry (TLM) signal. The control circuit 35 is used to adjust the settings of the Schottky diode distortion generator 24a, the phase shifter 23, the PIN diode attenuator 25, and the gain and attenuation settings of the output amplifier 32 and output attenuator 33. The bilevel telemetry (TLM) signal is used as a mode indicator for ground command control.

[0017] Referring to Fig. 3, it shows a detailed schematic diagram of the linearizer bridge circuit 30 of Fig. 2. The fixed delay line 22a comprises a bent 50 ohm line, which is employed to compensate the delay between the linear and nonlinear arms 21a, 21b, reduce dispersion and improve the operating frequency band. The phase shifter 23 comprises two pairs of PIN diode reflection attenuators. This circuit provides 360° phase shifting with constant insertion loss. Details of the construction of the phase shifter 23 may be found in U.S. Patent No. 5,317,288. The nonlinear Schottky diode distortion generator circuit 24a comprises a Lange coupler and two diodes to form a balanced reflection circuit. With properly applying DC bias, this circuit works at low power levels (c-3 dBm) as well as higher power levels. In addition, the gain curve can be easily manipulated by selection of the DC bias level applied to the distortion generator circuit 24a. The PIN diode attenuator 25 comprises six diodes and is used to adjust the output power of the nonlinear arm 21b. In bypass mode, the PIN attenuator provides greater than 35 dB attenuation, which makes the linearizer bridge circuit 30 a linear circuit.

[0018] The linearizer bridge circuit 30 operates as follows. The linearizer bridge 15a has two operational

modes; active mode and bypass mode. In the active mode, the linearizer bridge 15a functions as a nonlinear circuit that provides up to 10 dB gain expansion with up to 90° phase advance. The gain expansion value and phase advance value are controlled by the phase shifter 23 and PIN diode attenuator 25. In addition, the gain curve can be adjusted by changing the bias supplied to the distortion generator 24a. In the bypass mode, the PIN diode attenuator 25 provides high attenuation in the nonlinear arm 21b. Therefore, the linearizer bridge 15a functions as a linear circuit.

[0019] Referring to Fig. 4, there is shown a block diagram of the control circuit 35 employed in the linearizer bridge circuit of Fig. 2. The control circuit 35 comprises a power supply 41 having 8.0 and 8.6 volt outputs that are filtered and regulated by a supply filtering and regulator circuit 42. The linearizer bridge circuit 30 is turned on and off by on and off signals (LIN ON, LIN OFF) input to a command receiver 43 which commands are coupled to a mode latch 44 for the active and bypass modes of the linearizer bridge circuit 30. A reset, power up and mode control circuit 45 is coupled to the mode latch 44 that controls these functions.

[0020] A temperature compensation circuit 46 is coupled to a set phase circuit 47, a set distortion circuit 48, a set attenuation 1 circuit 52, and a set attenuation 2 circuit 53. Based upon the output of the temperature compensation circuit 46 the set phase circuit 47, set distortion circuit 48, set attenuation 1 circuit 52, and set attenuation 2 circuit 53 drive voltage controlled current sources 55 coupled thereto. Two voltage controlled current sources 55 provide phase A and phase B drive signals to the phase shifter 23. Two voltage controlled current sources 55 provide distortion A and distortion B drive signals to the Schottky diode distortion generator 24a.

[0021] The set attenuation 1 circuit 52 outputs two attenuation values to a first switch 51 which is controlled by the mode latch 44 to selectively drive a voltage controlled current source 55 that provides a first attenuator drive signal (ATTEN 1 DRIVE) that is supplied to the PIN diode attenuator 25. The set attenuation 2 circuit 53 outputs an attenuation value to drive a voltage controlled current source 55 that provides a second attenuator drive signal (ATTEN 2 DRIVE) that is supplied to the output attenuator 33. The output of the mode latch 44 is also coupled to a second switch 54 that selects between a +5 volt and ground signal that generates the mode bilevel telemetry (MODE TLM) signal.

[0022] The control circuit 35 provides DC bias for the distortion generator 24a, the PIN diode attenuator 25, and the phase shifter 23 to control the phase advance and gain expansion values. The control circuit 35 also provides DC bias for the output amplifier 32 and output attenuator 33 to control the gain levels thereof. A temperature compensation circuit is employed in the control circuit 35 to compensate for changes of temperature of the distortion generator 24a, attenuators 25, 33 and phase shifter 23 to provide constant performance over a wide temperature range. The control circuit 35 switches the linearizer bridge 15a between active and bypass modes, and provides the bilevel telemetry signal as a mode indicator for ground command control.

[0023] By properly adjusting the settings of the Schottky diode distortion generator 24a, the phase shifter 23, and the PIN diode attenuator 25, desired gain expansion and phase advance with respect to the power level of the RF input signal applied to the linearizer bridge circuit 30 is achieved. This cancels the gain compression and phase lag generated by the travelling wave tube amplifier 20 and therefore improves its linearity performance (third-order intermodulation, phase, and AM/PM conversion).

[0024] The linearizer bridge circuit 30 operates in active and bypass modes. In bypass mode, the attenuation of the nonlinear arm 21b is increased to greater than 30 dB, forcing the RF input signal to only pass through the linear arm 21a. Therefore, the linearizer bridge circuit 15 provides both active and bypass mode functions.

[0025] An integrated Ku-band linearizer bridge circuit 30 has been reduced to practice and is used with a travelling wave tube amplifier 20. The phase shifter 23, Schottky diode distortion generator 24a, attenuator 25, and delay line 22 are fabricated on a single alumina substrate 26. The Ku-band linearizer bridge circuit 30 that was reduced to practice has the advantages of compact size, a relatively small number of circuits, and may be manufactured with reduced assembly and RF tuning and setting labour compared to a currently used multicarrier amplifier design.

[0026] The reduced to practice embodiment of the linearizer bridge circuit 30 has an operating frequency of 19.1 GHz to 19.2 GHz, its gain is about 15 dB, and its power consumption is about 0.95 watt. The mass of the linearizer bridge circuit 30 is about 257 grams and has dimensions of 18 centimetres by 3.5 centimetres by 3.5 centimetres. The DC input voltage provided to the linearizer bridge circuit 30 may be between ± 7 volts.

[0027] Thus, an improved linearizer bridge circuit for use with travelling wave tube amplifiers has been disclosed. It is to be understood that the described embodiment is merely illustrative of some of the many specific embodiments which represent applications of the principles of the present invention.

Claims

1. A linearizer bridge circuit (30) for use with a travelling wave tube amplifier, comprising a linearizer bridge (15a) comprising an RF input (11) for receiving an RF input signal, a linear arm (21a) comprising a fixed delay line (22a) and a diode phase shifter (23), a nonlinear arm (21b) comprising a nonlinear Schottky diode distortion generator circuit (24a) and a PIN diode attenuator (25), an input coupler (27a)

for coupling the RF input signal to the linear and nonlinear arms of the linearizer bridge, and an output coupler (27b) for combining the RF signals from the linear and nonlinear arms to provide an RF output signal from the linearizer bridge, an output amplifier (32) coupled to the linearizer bridge for amplifying the RF output signal from the linearizer bridge, and an output attenuator (33) coupled to the output amplifier for providing an RF output signal from the linearizer bridge circuit, wherein the improvement is **characterized by**:

a control circuit (35) coupled to the phase shifter (23), the nonlinear Schottky diode distortion generator circuit (24a), the PIN diode attenuator (25), the output amplifier (32) and the output attenuator (33), for applying selected amounts of bias to the Schottky diode distortion generator, the phase shifter, and the PIN diode attenuator to lower the operational power level of the linearizer bridge circuit and selectively adjust the phase advance gain expansion and gain curvature of the linearizer bridge circuit, and for appying selected amounts of bias to the output amplifier and output attenuator to set the respective gain and attenuation values thereof;
and wherein proper adjustment of the settings of the Schottky diode distortion generator, the phase shifter, and the PIN diode attenuator, produces a desired gain expansion and phase advance with respect to the power level of the RF input signal applied to the linearizer bridge circuit, which cancels the gain compression and phase lag generated by the travelling wave tube amplifier to improve its linearity performance.

2. A linearizer bridge circuit as claimed in Claim 1, wherein the linearizer bridge circuit operates in active and bypass modes.

3. A linearizer bridge circuit as claimed in Claim 2 wherein, when the linearizer bridge circuit operates in bypass mode, the attenuation of the nonlinear arm (21b) is increased to greater than 35 dB, forcing the RF input signal to only pass through the linear arm (21a).

4. The linearizer bridge circuit of Claim 1, wherein the control circuit processes commands that switch the linearizer bridge circuit between active mode wherein predetermined levels of bias are applied to the phase shifter and diode attenuator to cause the nonlinear bridge to function as a nonlinear circuit to provide a predetermined amount of gain expansion and phase advance and bypass mode, wherein a predetermined level of bias is applied to the diode attenuator to cause it to produce sufficient attenuation in the nonlinear arm to cause the linearizer bridge to function as a linear circuit.

5. A linearizer bridge circuit as claimed in any one of the preceding claims, wherein the linearizer bridge is fabricated on a single substrate (26).

6. A linearizer bridge circuit as claimed in Claim 5, wherein the substrate (26) comprises an alumina substrate.

7. The linearizer bridge circuit of Claim 1, wherein the control circuit has one or more inputs for receiving on and off input command signals that turn the linearizer bridge circuit on and off.

8. The linearizer bridge circuit of Claim 1, wherein the control circuit has an output for outputting a bilevel telemetry signal that provides a mode indicator for ground command control.

Patentansprüche

1. Linearisierungsbrückenschaltung (30) zur Verwendung mit einem Wanderwellenröhrenverstärker, umfassend eine Linearisierungsbrücke (15a) umfassend einen RF-Einlass (11) zum Empfangen eines RF-Eingangssignals, einen linearen Arm (21a) umfassend eine feste Laufzeitkette (22a) und einen Diodenphasenschieber (23), einen nichtlinearen Arm (21 b) umfassend eine nichtlineare Schottky-Diodenverzerrungsgeneratorschaltung (24a) und einen PIN-Diodendämpfer (25), einen Eingangskoppler (27a) zum Koppeln des RF-Eingangssignals mit den linearen und nichtlinearen Armen der Linearisierungsbrücke, und einen Ausgangskoppler (27b) zum Kombinieren der RF-Signale von den linearen und nichtlinearen Armen zum Bereitstellen eines RF-Ausgangssignals von der Linearisierungsbrücke, einen mit der Linearisierungsbrücke gekoppelten Ausgangsverstärker (32) zum Verstärken des RF-Ausgangssignals von der Linearisierungsbrücke, und einen mit dem Ausgangsverstärker gekoppelten Ausgangsdämpfer (33) zum Bereitstellen eines RF-Ausgangssignals von der Linearisierungsbrückenschaltung, worin die Verbesserung **gekennzeichnet ist durch**:

eine Steuerungsschaltung (35) gekoppelt mit dem Phasenschieber (23), der nichtlinearen Schottky-Diodenverzerrungsgeneratorschaltung (24a), dem PIN-Diodendämpfer (25), dem Ausgangsverstärker (32) und dem Ausgangsdämpfer (33), um ausgewählte Beträge an Vorspannung auf den Schottky-Diodenverzerrungsgenerator, den Phasenschieber und den PIN-Diodendämpfer aufzubringen, um den Be-

triebsenergiewert der Linearisierungsbrückenschaltung zu senken und die Phasenvoreilverstärkungsexpansion und Verstärkungskurve der Linearisierungsbrückenschaltung selektiv einzustellen, und um ausgewählte Beträge an Vorspannung auf den Ausgangsverstärker und Ausgangsdämpfer aufzubringen, um die entsprechenden Verstärkungs- und Dämpfungswerte davon festzusetzen;
und worin geeignete Einstellung der Vorgaben des Schottky-Diodenverzerrungsgenerators, des Phasenschiebers und des PIN-Diodendämpfers eine gewünschte Verstärkungsexpansion und Phasenvoreilung in Bezug auf den Energiewert des auf die Linearisierungsbrükkenschaltung aufgebrachten RF-Eingangssignals ergibt, was die Verstärkungskompression und Phasennacheilung löscht, die **durch** den Wanderwellenröhrenverstärker erzeugt sind, um sein Linearitätsverhalten zu verbessern.

2. Linearisierungsbrückenschaltung nach Anspruch 1, worin die Linearisierungsbrückenschaltung in aktivem Betrieb und Bypassbetrieb betreibbar ist.

3. Linearisierungsbrückenschaltung nach Anspruch 2, worin, wenn die Linearisierungsbrückenschaltung im Bypassbetrieb betrieben wird, die Dämpfung des nichtlinearen Arms (21b) auf mehr als 35 dB erhöht ist, was das RF-Eingangssignal zwingt, nur durch den linearen Arm (21a) zu laufen.

4. Linearisierungsbrückenschaltung nach Anspruch 1, worin die Steuerungsschaltung Befehle verarbeitet, die die Linearisierungsbrückenschaltung umschalten zwischen aktivem Betrieb, worin bestimmte Vorspannungswerte auf den Phasenschieber und den Diodendämpfer aufgebracht werden, um die nichtlineare Brücke zu veranlassen, als nichtlineare Schaltung zu funktionieren, um ein bestimmtes Maß an Verstärkungsexpansion und Phasenvoreilung und Bypassbetrieb bereitzustellen, worin ein bestimmter Vorspannungswert auf den Diodendämpfer aufgebracht wird, um ihn zu veranlassen, ausreichend Dämpfung im nichtlinearen Arm zu bewirken, um die Linearisierungsbrücke zu veranlassen, als lineare Schaltung zu funktionieren.

5. Linearisierungsbrückenschaltung nach einem der vorhergehenden Ansprüche, worin die Linearisierungsbrücke auf einem einzigen Substrat (26) gefertigt ist.

6. Linearisierungsbrückenschaltung nach Anspruch 5, worin das Substrat (26) ein Aluminiumoxidsubstrat umfasst.

7. Linearisierungsbrückenschaltung nach Anspruch 1, worin die Steuerungsschaltung einen oder mehrere Einlässe aufweist zum Empfangen von Ein- und Aus-Eingangsbefehlssignalen, die die Linearisierungsbrückenschaltung ein- und ausschalten.

8. Linearisierungsbrückenschaltung nach Anspruch 1, worin die Steuerungsschaltung einen Auslass zum Ausgeben eines doppelten Telemetriesignals aufweist, das einen Betriebsindikator für eine Bodenbefehlssteuerung bereitstellt.

Revendications

1. Circuit en pont de linéarisation (30) qui est destiné à l'utilisation avec un amplificateur à tubes à onde progressive et qui comprend un pont de linéarisation (15a) comprenant une entrée haute fréquence (11) pour la réception d'un signal d'entrée à haute fréquence, une branche linéaire (21a) comprenant une ligne à retard fixe (22a) et un circuit déphaseur à diode (23), une branche non linéaire (21b) comprenant un circuit générateur de distorsion non linéaire (24a) à diode Schottky et un atténuateur (25) à diode PIN, un coupleur d'entrée (27a) pour le couplage du signal d'entrée à haute fréquence avec les branches linéaire et non linéaire du pont de linéarisation (15a), un coupleur de sortie (27b) pour la combinaison des signaux à haute fréquence provenant des branches linéaire et non linéaire pour fournir un signal de sortie à haute fréquence provenant du pont de linéarisation (15a), un amplificateur de sortie (32), qui est couplé avec le pont de linéarisation (15a) pour amplifier le signal de sortie à haute fréquence provenant du pont de linéarisation (15a), et un atténuateur de sortie (33), qui est couplé avec l'amplificateur de sortie (32) pour fournir un signal de sortie à haute fréquence provenant du circuit en pont de linéarisation (30), dans lequel le perfectionnement est **caractérisé par** :

un circuit de commande (35) qui est couplé avec le circuit déphaseur (23), le circuit générateur de distorsion non linéaire (24a) à diode Schottky, l'atténuateur (25) à diode PIN, l'amplificateur de sortie (32) et l'atténuateur de sortie (33) pour appliquer des valeurs sélectionnées de polarisation au circuit générateur de distorsion non linéaire (24a) à diode Schottky, au circuit déphaseur (23) et à l'atténuateur (25) à diode PIN pour diminuer le niveau de puissance opérationnel du circuit en pont de linéarisation (30) et ajuster de manière sélective l'extension du gain en avance de phase et la courbe de gain du circuit en pont de linéarisation (30), et pour appliquer des valeurs sélectionnées de polarisation à l'amplificateur de

sortie (32) et à l'atténuateur de sortie (33) pour régler les valeurs respectives du gain et de l'atténuation de ce dernier,
et dans lequel un ajustement approprié des réglages du circuit générateur de distorsion non linéaire (24a) à diode Schottky, du circuit déphaseur (23) et de l'atténuateur (25) à diode PIN produit une extension du gain et une avance de phase désirées par rapport au niveau de puissance du signal d'entrée à haute fréquence qui est appliqué au circuit en pont de linéarisation (30), ce qui supprime la compression du gain et le retard de phase engendrés par l'amplificateur à tubes à onde progressive afin d'améliorer sa caractéristique de linéarité.

2. Circuit en pont de linéarisation selon la revendication 1, dans lequel le circuit en pont de linéarisation (30) fonctionne en mode actif et en mode dérivation.

3. Circuit en pont de linéarisation selon la revendication 2, dans lequel le circuit en pont de linéarisation (30) fonctionne en mode dérivation et l'atténuation de la branche non linéaire (21b) est augmentée à une valeur supérieure à 35 dB, ce qui force le signal d'entrée à haute fréquence à passer seulement dans la branche linéaire (21a).

4. Circuit en pont de linéarisation selon la revendication 1, dans lequel le circuit de commande (35) traite des commandes qui commutent le circuit en pont de linéarisation (30) entre le mode actif, dans lequel on applique des niveaux prédéterminés de polarisation au circuit déphaseur (23) et à l'atténuateur (25) à diode pour forcer le pont non linéaire à fonctionner en tant que circuit non linéaire pour fournir une valeur prédéterminée de l'extension du gain et de l'avance de phase, et un mode de dérivation, dans lequel on applique un niveau prédéterminé de polarisation à l'atténuateur (25) à diode pour le forcer à produire une atténuation suffisante dans la branche non linéaire (21b) pour forcer le pont de linéarisation (15a) à fonctionner en tant que circuit linéaire.

5. Circuit en pont de linéarisation selon l'une quelconque des revendications précédentes, dans lequel le pont de linéarisation (15a) est fabriqué sur un substrat unique (26).

6. Circuit en pont de linéarisation selon la revendication 5, dans lequel le substrat unique (26) comprend un substrat en oxyde d'aluminium.

7. Circuit en pont de linéarisation selon la revendication 1, dans lequel le circuit de commande (35) a une ou plusieurs entrées pour recevoir des signaux de commande d'entrée de mise en route et d'arrêt qui mettent en route ou arrêtent le pont de linéarisation (15a).

8. Circuit en pont de linéarisation selon la revendication 1, dans lequel le circuit de commande (35) a une sortie pour fournir en sortie un signal de télémesure à deux niveaux qui fournit un indicateur de mode pour la commande de terre.

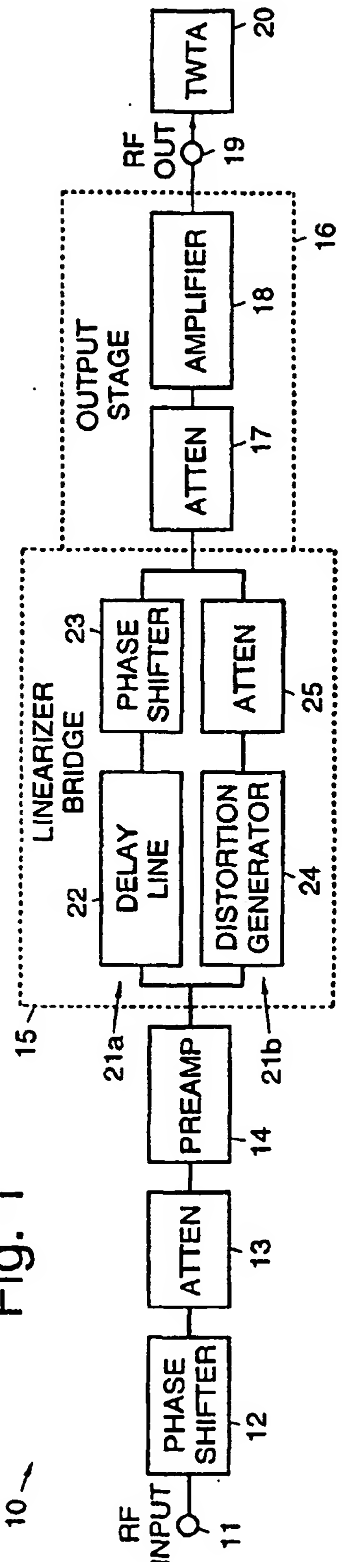
10
RF INPUT
11
PHASE SHIFTER
12
ATTEN
13
PREAMP
14
15
21a
21b
LINEARIZER BRIDGE
DELAY LINE
22
DISTORTION GENERATOR
24
PHASE SHIFTER
23
ATTEN
25
OUTPUT STAGE
16
ATTEN
17
AMPLIFIER
18
RF OUT
19
TWTA
20

Fig. 1

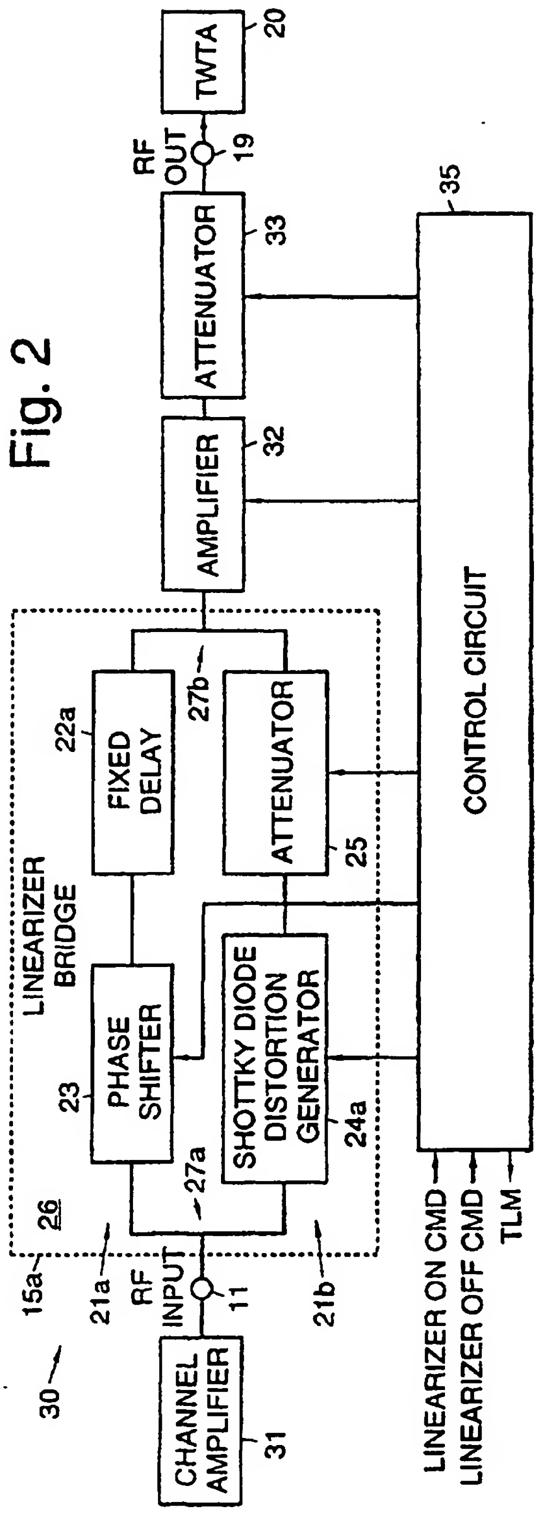
30
CHANNEL AMPLIFIER
31
RF INPUT
11
15a
21a
21b
26
LINEARIZER BRIDGE
27a
PHASE SHIFTER
23
SHOTTKY DIODE DISTORTION GENERATOR
24a
FIXED DELAY
22a
ATTENUATOR
25
27b
AMPLIFIER
32
ATTENUATOR
33
RF OUT
19
TWTA
20
CONTROL CIRCUIT
35
LINEARIZER ON CMD
LINEARIZER OFF CMD
TLM

Fig. 2

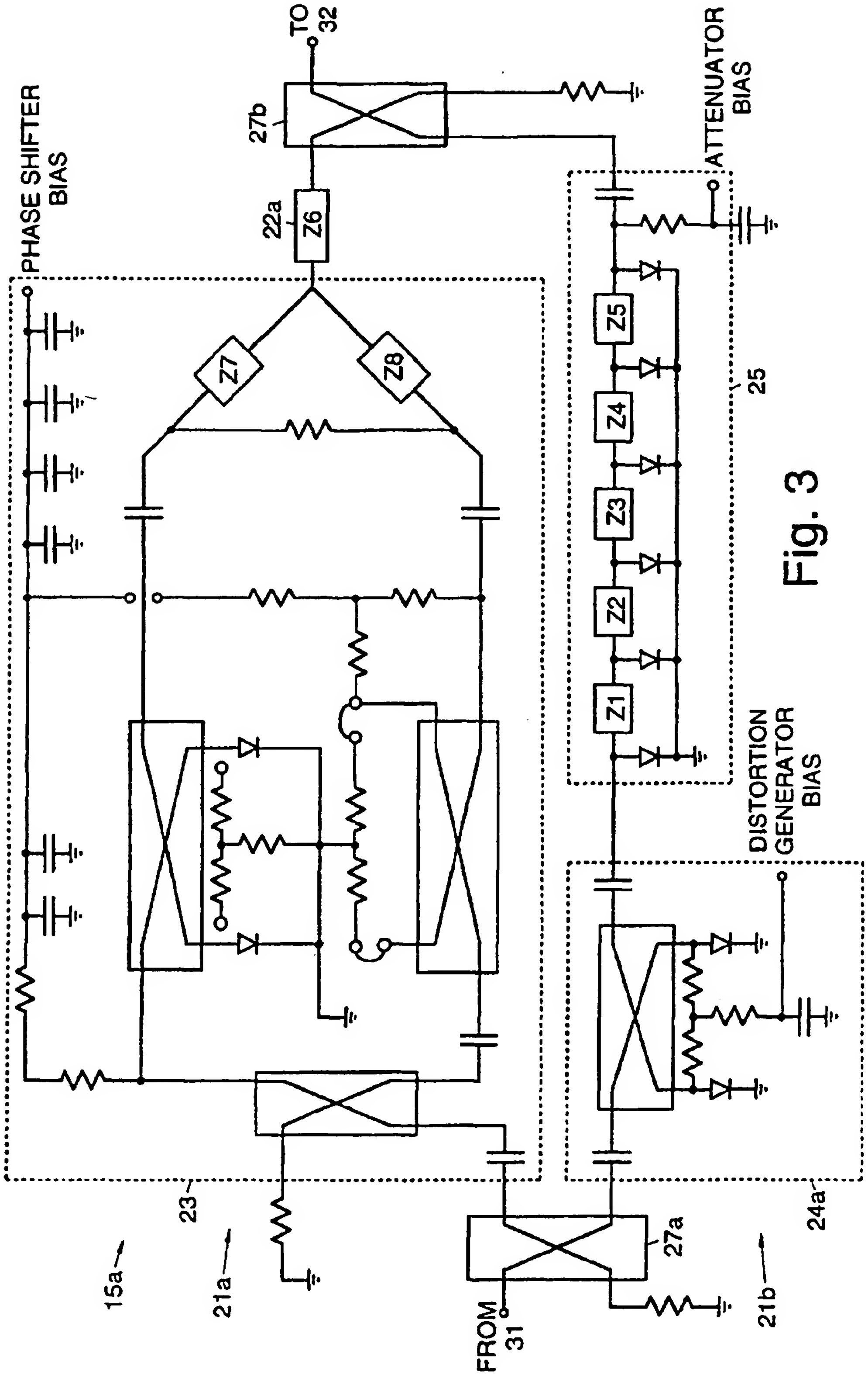
PHASE SHIFTER BIAS
TO 32
27b
22a
Z6
Z7
Z8
ATTENUATOR BIAS
Z1
Z2
Z3
Z4
Z5
25
DISTORTION GENERATOR BIAS
23
24a
27a
15a
21a
21b
FROM 31

Fig. 3

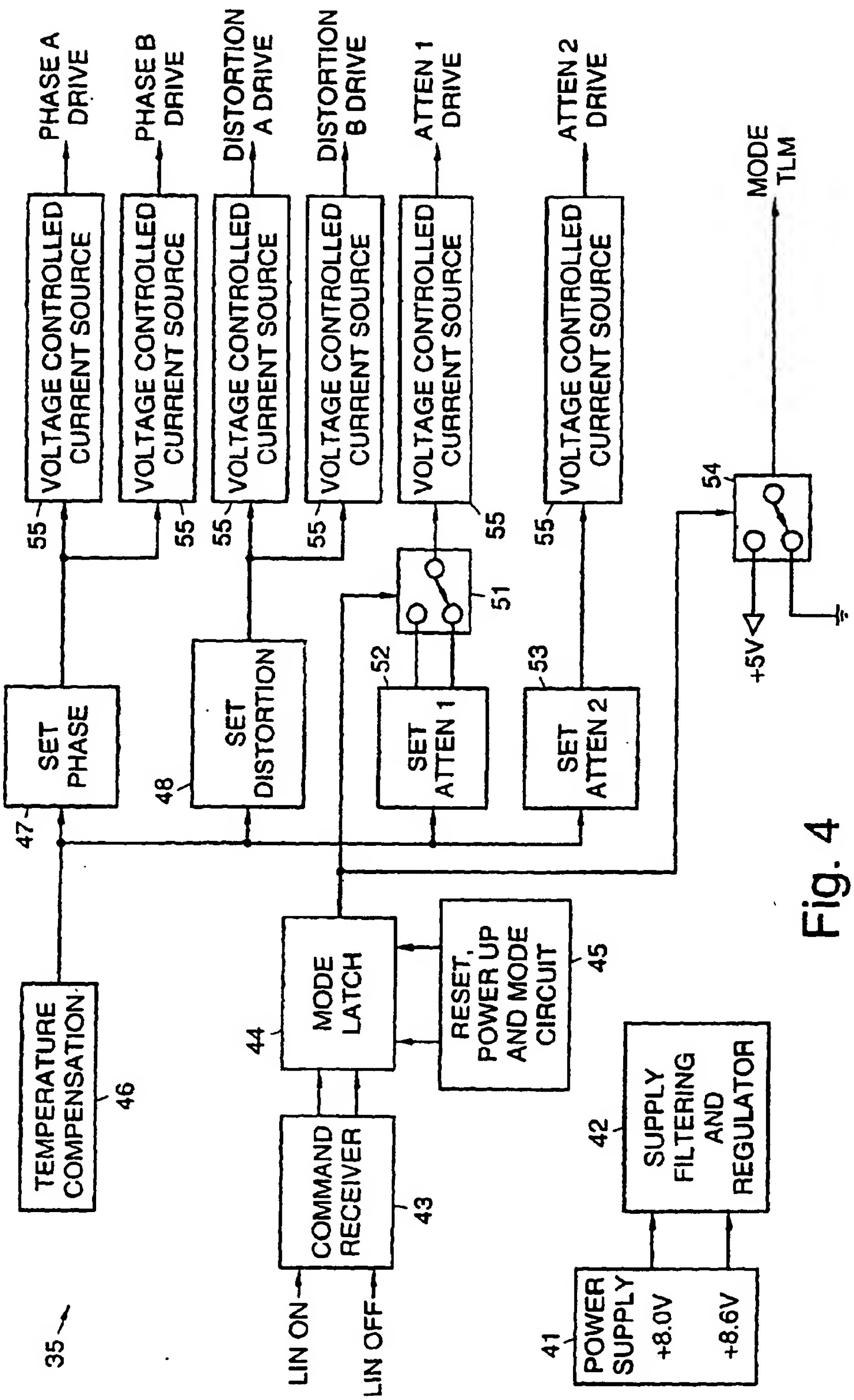
35
TEMPERATURE COMPENSATION
46
47
SET PHASE
48
SET DISTORTION
52
SET ATTEN 1
53
SET ATTEN 2
51
54
+5V
VOLTAGE CONTROLLED CURRENT SOURCE
55
PHASE A DRIVE
PHASE B DRIVE
DISTORTION A DRIVE
DISTORTION B DRIVE
ATTEN 1 DRIVE
ATTEN 2 DRIVE
MODE TLM
LIN ON
LIN OFF
COMMAND RECEIVER
43
MODE LATCH
44
RESET, POWER UP AND MODE CIRCUIT
45
POWER SUPPLY
41
+8.0V
+8.6V
SUPPLY FILTERING AND REGULATOR
42

Fig. 4